

*Lockheed Aircraft Corporation***ADVANCED DEVELOPMENT PROJECTS**
BURBANK, CALIFORNIAREPORT NO. SP-1496DATE 7-17-69COPY NO. 2**MODEL** U2R**TITLE** QUALIFICATION TEST OF U2R ESCAPE SYSTEM

STATINTL

PREPARED BY



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REVIEWED BY



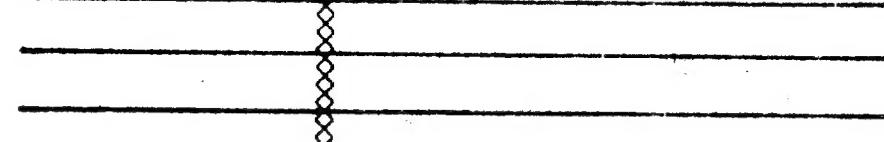
STATINTL

APPROVED BY

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Vice President
Advanced Development Projects**REVISIONS**

DATE

PAGES AFFECTED



QUALIFICATION TEST OF U-2R ESCAPE SYSTEM

1.0 PURPOSE

The following tests were conducted to prove that the U-2R Escape System would operate under any condition to be expected for the airplane.

2.0 EXTENT OF TEST

The seat, parachute, survival kit, and catapult were qualified on a previous project for operation between zero speed-zero altitude and maximum speed and maximum altitude. However, for this application the seat was modified by the addition of a canopy breaker to allow ejection in case of a canopy failure.

The pyrotechnic system was revised and simplified to provide for the ejection through the canopy.

The stick stowing mechanism resembled that used previously but was enhanced by a lock to prevent rebound. Timing was critical and was recorded by movies to show the results.

Thru the canopy tests were made with production components and production configurations with the exception of the 1.0 second delay initiator in lieu of the "D" ring cable cutter. This initiator fired the seat recovery drogue gun. The "D" ring cable cutter has been proven in previous tests.

The seat was so positioned that the canopy breaker was one inch from the canopy. This represents the full up adjustment of the seat.

The test temperatures varied and are mentioned in the discussions of the individual tests.

An applicable part of this report is the moving pictures taken of the various tests. These show the results better than the following discussions. The picture number is 336.

3.0 TESTS CONDUCTED AND THE RESULTS

3.1 Canopy Jettison

Six tests were run to arrive at the optimum result. The canopy now

will clear the cockpit in order that the seat and pilot can clear without interference from the canopy. See Figures 1 and 2.

3.2 Ejection through the Canopy

Two tests were run to prove the System capable of forcing the seat and pilot through the closed canopy in case of malfunction of the canopy jettison system. One test was conducted at ambient temperature of 80°F and one test at -65°F to prove that the System was capable of breaking through the canopy at either temperature. See Figure 3 and the movies for the effectiveness of this operation.

3.3 Stick Stowage

3.3.1 Five tests were run to prove that the control wheel would be stowed and locked in a position to allow unfettered egress of the pilot. See the movies for the sequence and timing of this test. See Figures 4 and 5.

3.3.2 This test was conducted to establish the minimum pressure necessary to shear the rivet and to move the control column to the stowed position and to determine the pressure developed by the System. See Figure 4. The pressure developed at -65°F by the System was 5263 psi compared to the minimum pressure required of 2779 psi.

3.4 Seat Stabilizing Drogue Gun

Two tests were run on the Drogue Chute to check that the addition of the canopy breaker does not prevent proper deployment of the chute. The movies show the effectiveness of the deployment.

3.5 Seat Lap Belt Test

This test was run to prove that the Seat Lap Belt will open at the System pressure. See Figure 6. It was determined that the belt with a tension load of 4000 pounds on it will open with a pressure of 2734 psi in the System. At -65°F the System developed 3059 psi - well above the required pressure. In this same test it was determined that at -65°F the foot cables will be cut and the "D" ring cable will be cut with the pressure developed.

3.6 Man-Seat Separation System

This test was run to prove that the pilot will be thrown from the seat at time of separation. See Figure 7 and especially see the movies where the ejection sequence plainly shows the separation.

3.7 Aneroid Initiator

This test proved that both aneroids will fire at 150°F and not develop too much pressure. See Figure 8. Note that the Lap Belt pressure was 5350 psi and the "D" ring cable cutter was 4940 psi well above the 2734 psi and 3129 psi respectively that were proved to be adequate in Test 3.5.

3.8 Environmental Test of Pyrotechnics and Plumbing

Standard production hoses, fittings, initiators, thrusters, and "O" rings were obtained from stock.

3.8.1 Hot Soak Test

Chamber temperature was held at 150°F for at least 30 minutes. Then the System was fired. This proved that even with the components at a high temperature the pressures were below the safe level of the various components. Note that the highest pressure recorded was 7169 psi shown in Figure 2 which was for Test 3.1.

3.8.2 Cold Soak Test

Chamber temperature for this test was held at -65°F for at least 30 minutes to thoroughly chill the pyrotechnics and other components. This test proved the System capable of developing the necessary pressures in a cold environment to make the System function properly. The minimum pressure recorded was 2260 psi but since all gas fired initiators, catapult, and thrusters fire at a minimum pressure of 500 psi, it is obvious that there is a large margin of safety.

4.0 DISCUSSION

These tests were conducted as nearly as possible to standard conditions that would be expected in actual operation. There were no flight tests made because the worst condition to be met is the zero speed-zero altitude through the canopy test. The tests of the individual components proved each one to be more than adequate, but the final conclusive proof is the tests recorded by the movie. Thorough study of the movie shows a close compliance with the required sequence of events as outlined on pages 4, 5, and 6. See also discussion in Appendix.

5.0 CONCLUSION

Based on the thoroughness and results of the foregoing tests, it is evident that the Escape System for the U-2R is qualified to accomplish its required function from a static ground position to maximum speed and altitude.

ESCAPE SYSTEM FUNCTION SEQUENCING
ABOVE 15,000 FEET

Pull "D" Ring

Time 0.0 Sec.

1. Canopy is jettisoned.
2. Feet are Powered back.
3. Stick is Stowed.
4. Faceplate Heat Battery is armed.

Time 0.3 Sec.

1. Shoulder Reel is locked.
2. Catapult is fired.

Time 0.5 Sec.

1. Gun deploys Drogue Chute.

Time 0.7 Sec.

1. Drogue Chute full open. Seat is stabilized.

Time 1.1 Sec.

1. Rocket thrust exhausted.

Time 1.3 Sec.

1. Aneroid controlled separation initiators armed.

Time 11.4 Sec.

1. Lower bridles cut.

DESCENT TO 15,000 FEET IN SITTING POSITION

1. Aneroid unblocks and initiators fire.
2. Lap belt releases.
3. Shoulder straps release with lap belt.
4. Foot cables cut.
5. "D" Ring cable cut.
6. Main seat separator strokes.

7. Main parachute arms

Time 0.2 Sec. from parachute arm.

a. Main parachute drogue gun fires.

Time 0.3 Sec.

Upper bridles cut.

Time 1.7 Sec.

Main parachute full open.

ESCAPE SYSTEM FUNCTION SEQUENCING

BELOW 15,000 FEET

Pull "D" Ring.

Time 0.0 Sec.

1. Canopy is jettisoned.
2. Feet are powered back.
3. Stick is stowed.
4. Faceplate heat battery is armed.

Time 0.3 Sec.

1. Shoulder reel is locked.
2. Catapult is fired.

Time 0.5 Sec.

1. Gun deploys Drogue Chute.

Time 0.7 Sec.

1. Drogue Chute full open. Seat is stabilized.

Time 1.1 Sec.

1. Rocket thrust exhausted.

Time 1.3 Sec.

1. Aneroid initiators fired.
2. Lap belt releases.
3. Shoulder straps release from lap belt.
4. Foot cables cut.
5. "D" ring cable cut.
6. Man-seat separator strokes.
7. Main parachute arms.

Time 0.2 Sec. from parachute arm.

1. Main parachute drogue gun fires.

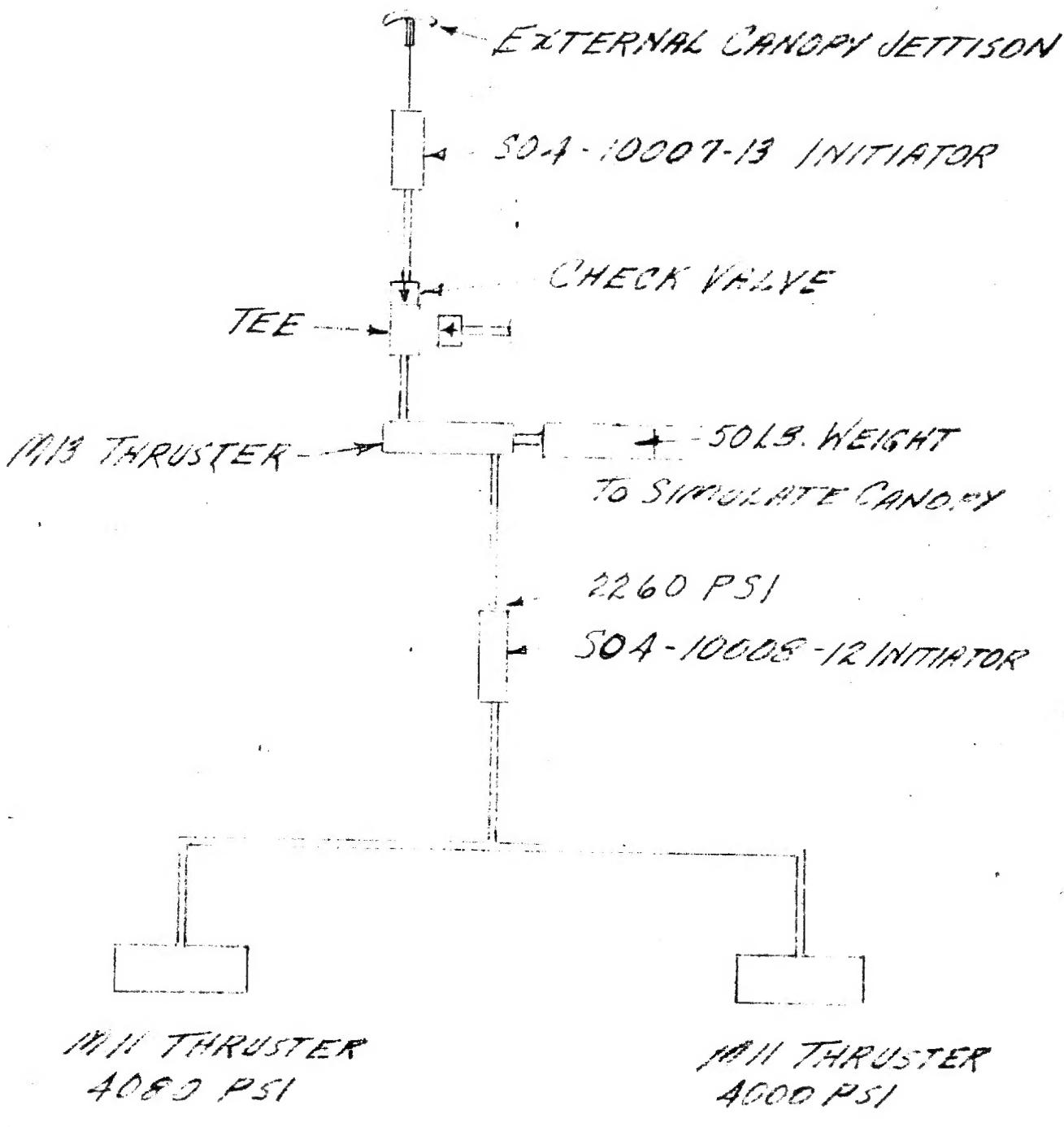
Time 1.6 Sec.

1. Upper bridles cut.

Time 3.0 Sec.

1. Main parachute full open.

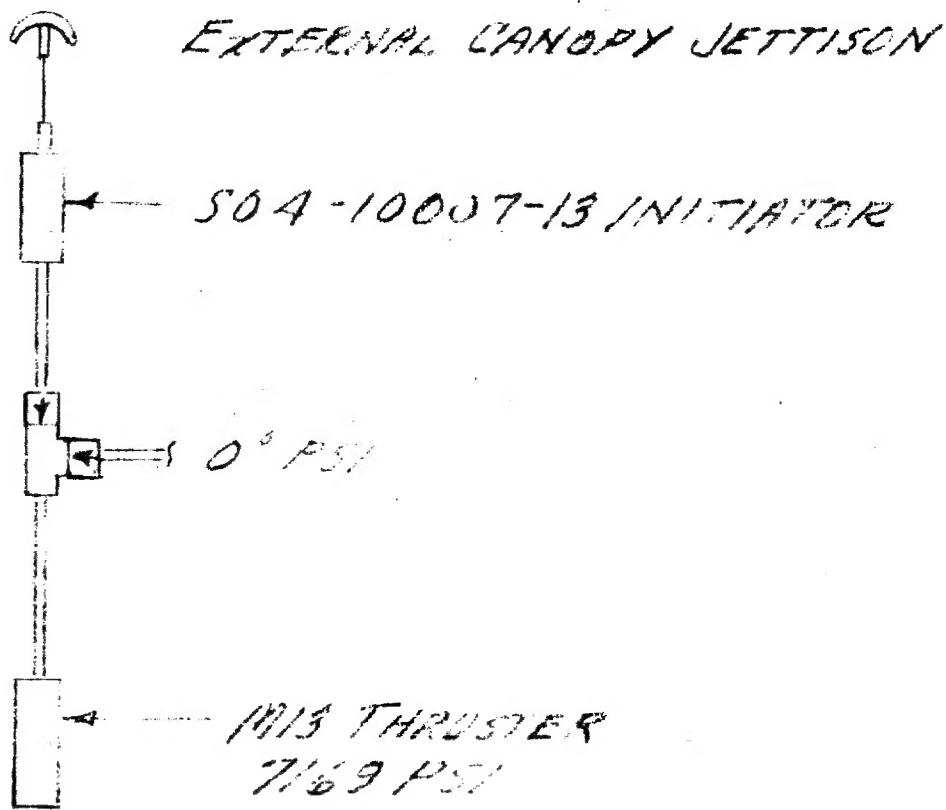
EXTERNAL CANOPY JETTISON SYSTEM
 -55°F TEST FOR TIME



TIME FROM FIRING OF SO-4-10007-13 INITIATOR
TO PRESSURE AT 11/11 THRUSTER 33 MILLISECONDS.

FIG. 1

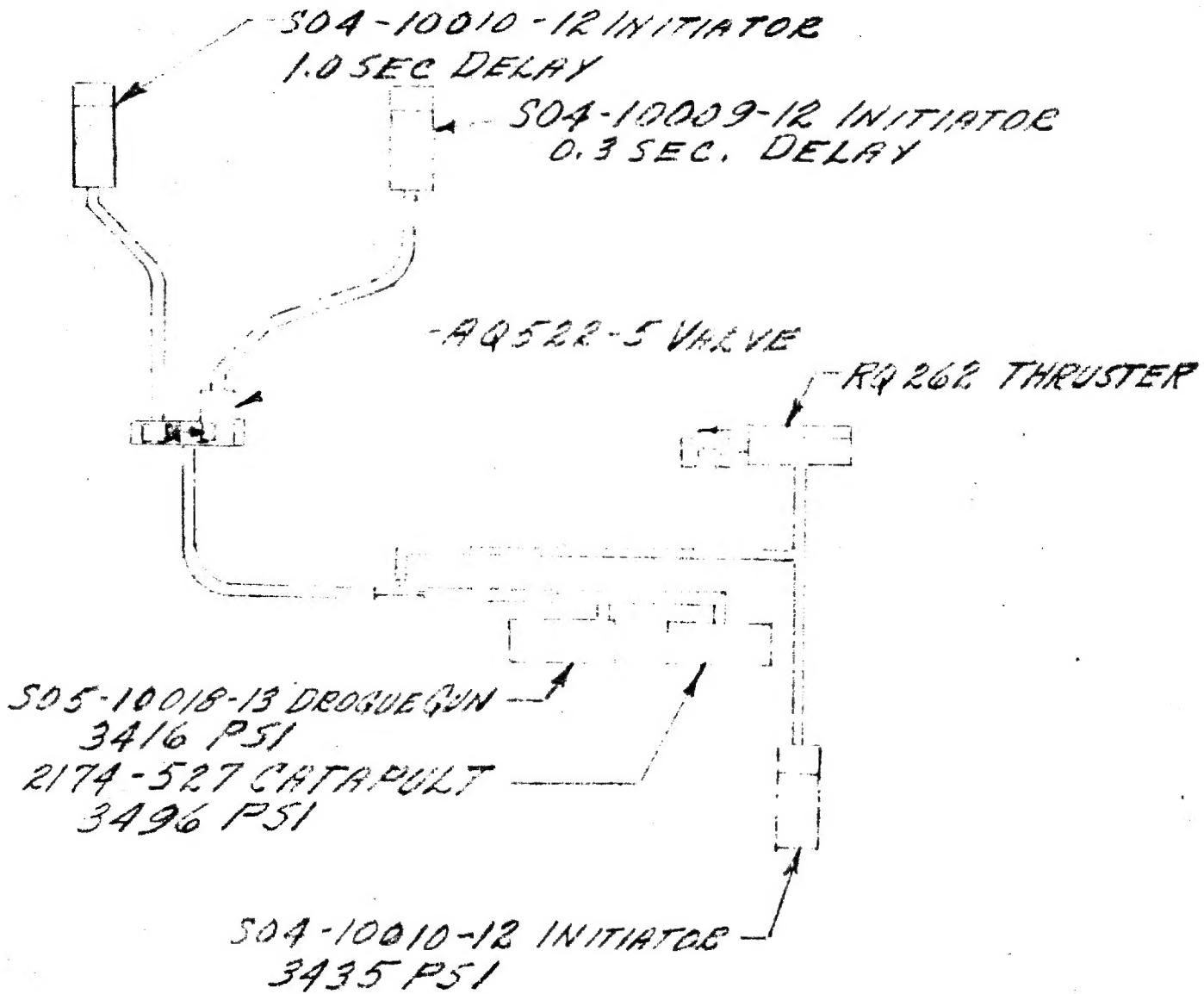
EXTERNAL CANOPY JETTISON MAX
PRESSURE SHORT HOSE TEST +150°F



NO BURSTS OR LEAKAGE APPARENT

11

EJECTION SYSTEM FROM THE 1.0 SECOND
DELAY INITIATOR AT -65°F



1. SHOULDER REEL WAS LOCKED BY RQ262 THRUSTER
2. PISTON IN AQ522-5 VALVE MOVED OVER AND
FUNCTIONED SATISFACTORILY.

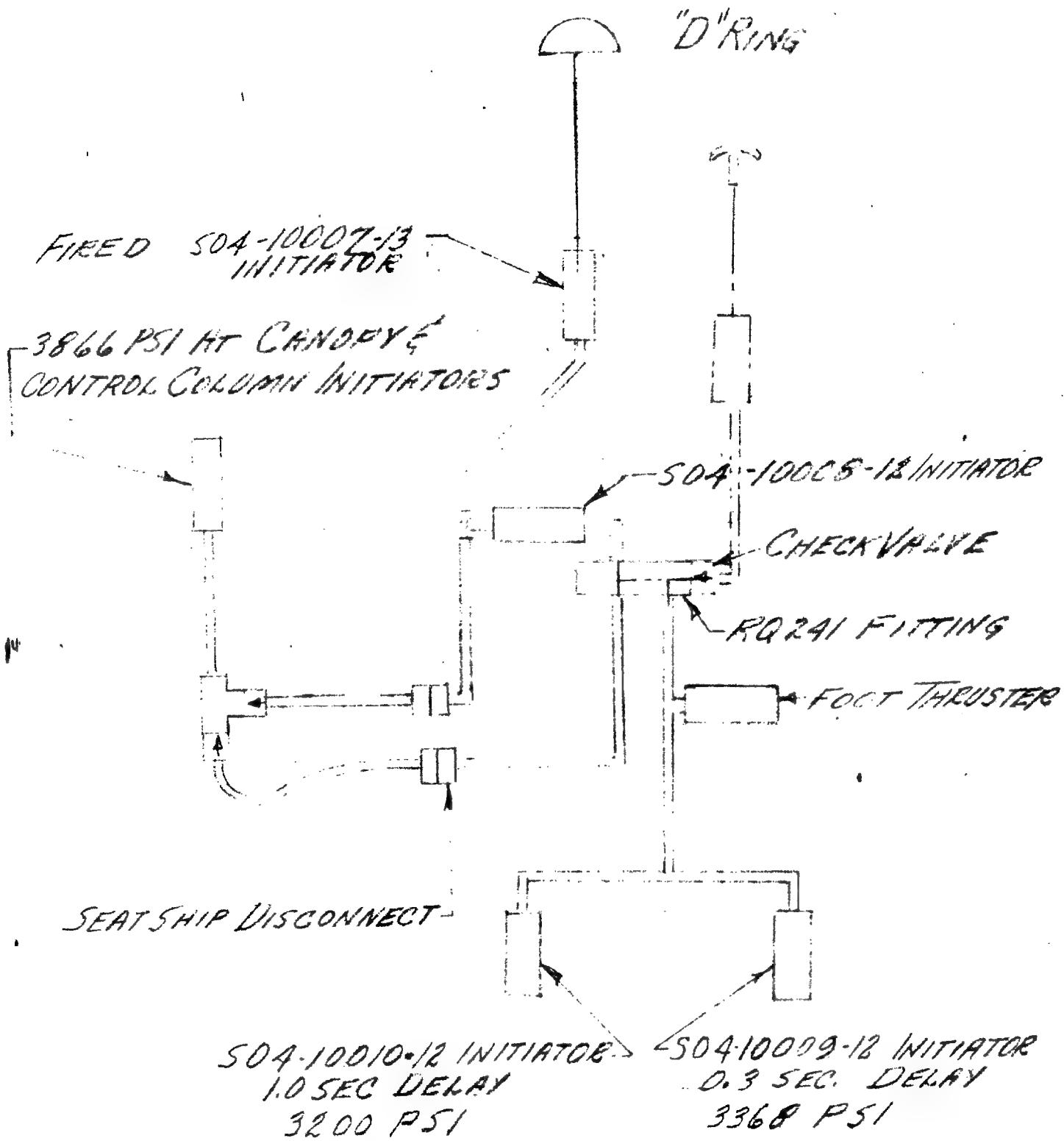
CONTROL COLUMN STOWAGE CRANK RC149
AT -65°F



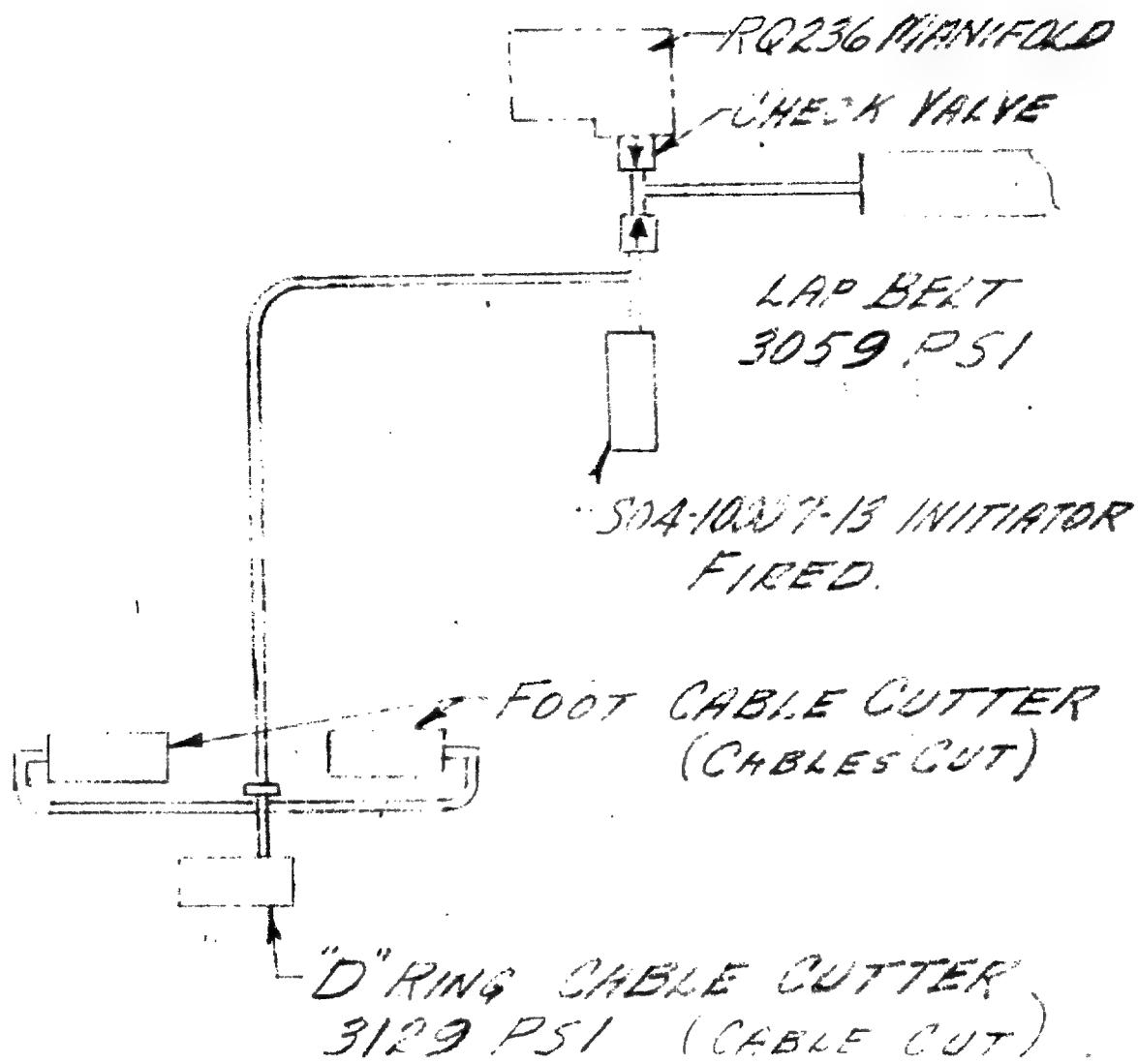
SD4-10008-12/INITIATOR →

TO SHEAR RIVET & TO MOVE LINKAGE 277.9 PSI.
PRESSURE AT CRANK 5263 PSI AT -65°F

"D" RING TO CANOPY CONTROL COLUMN INITIATOR
+150°F

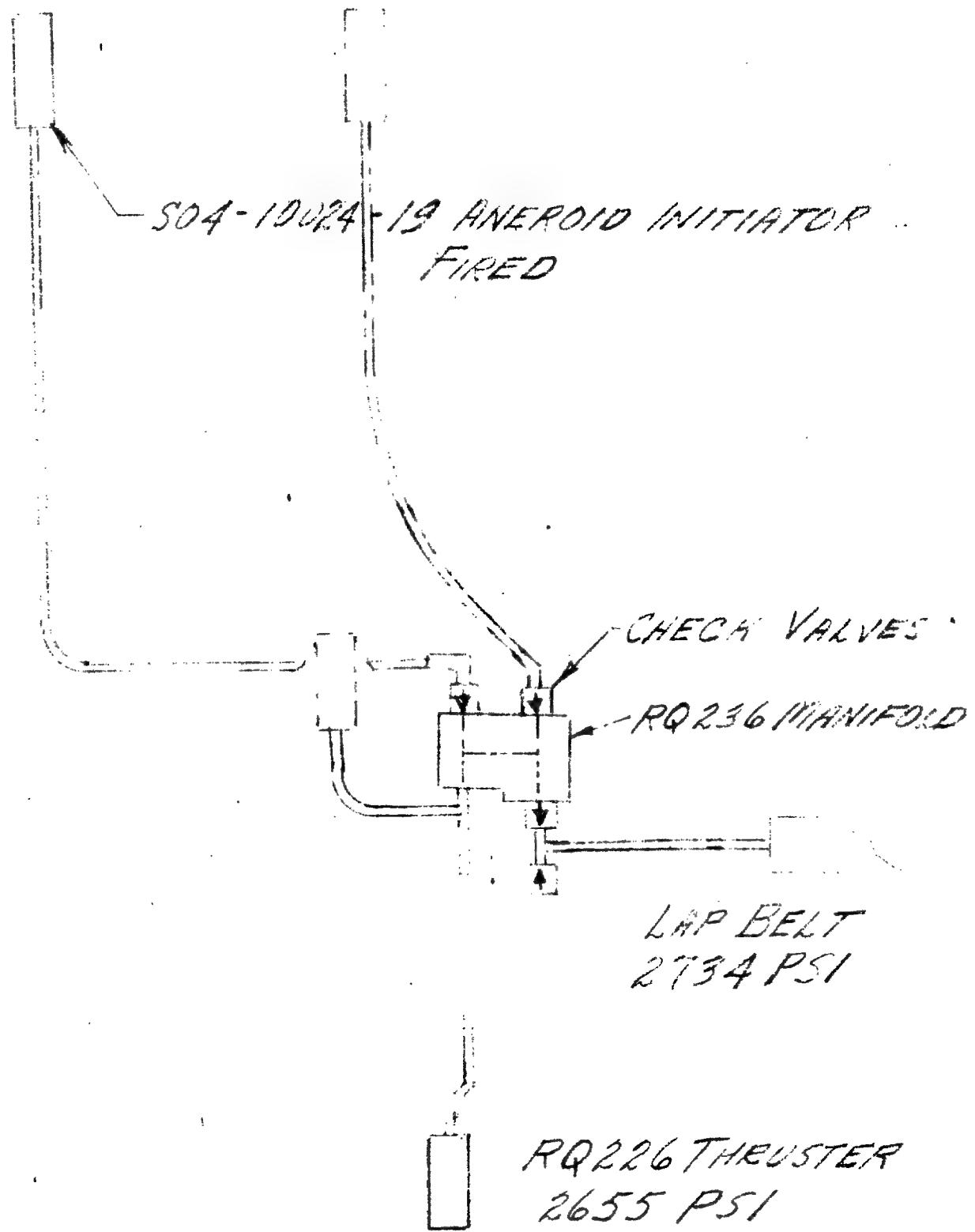


MANUAL RELEASE - LAP BELT, FOOT CABLE & "D" RING
CABLE HT - 65°F

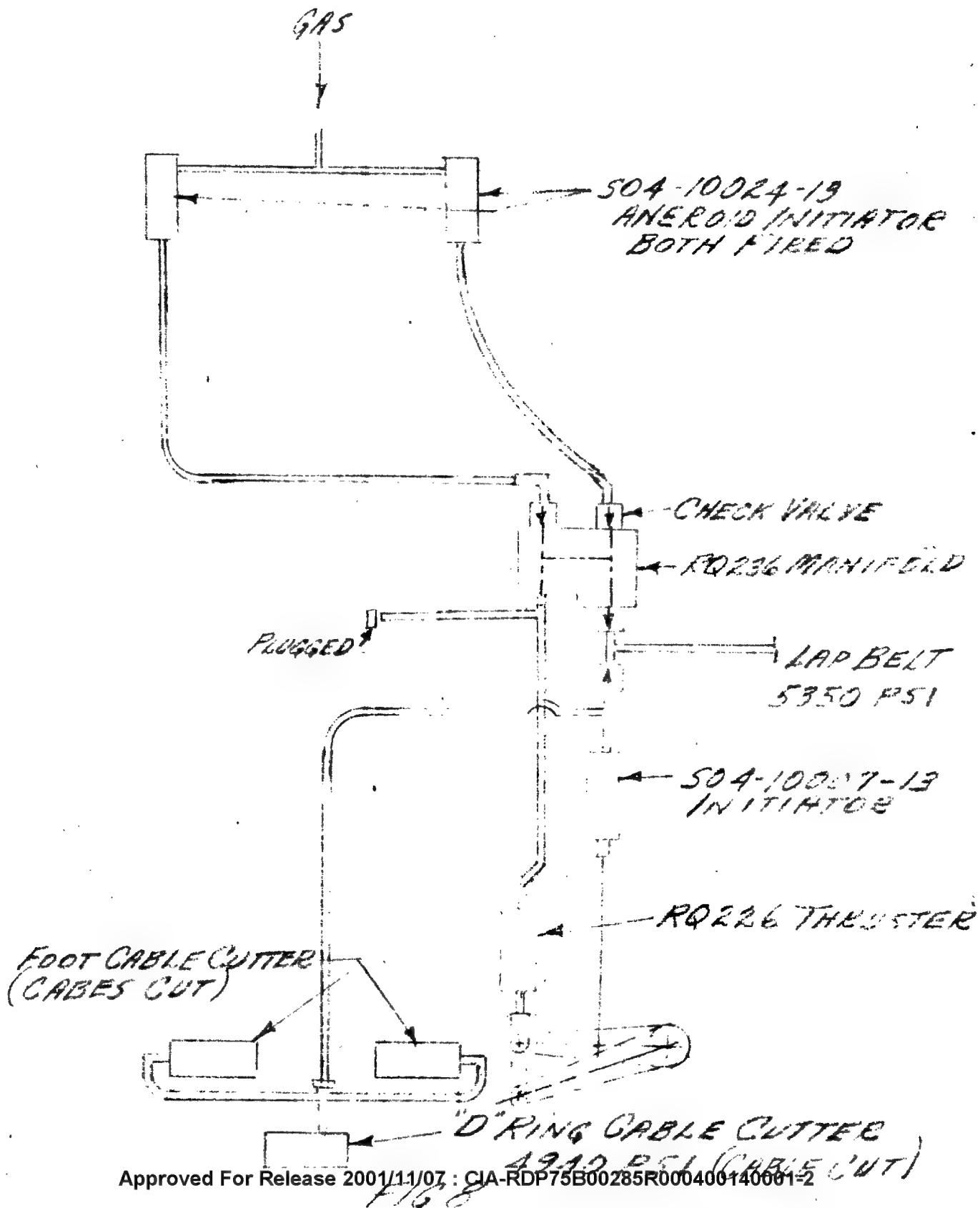


MANUAL RELEASE IS OVER THE SIDE EGRESS HT
ALTITUDE OR FOR DITCHED AIRPLANE.

MAN-SEAT SEPARATION SYSTEM
AT -65°F



ANEROID INITIATOR TEST BOTH FIRED
+150°F



APPENDIX

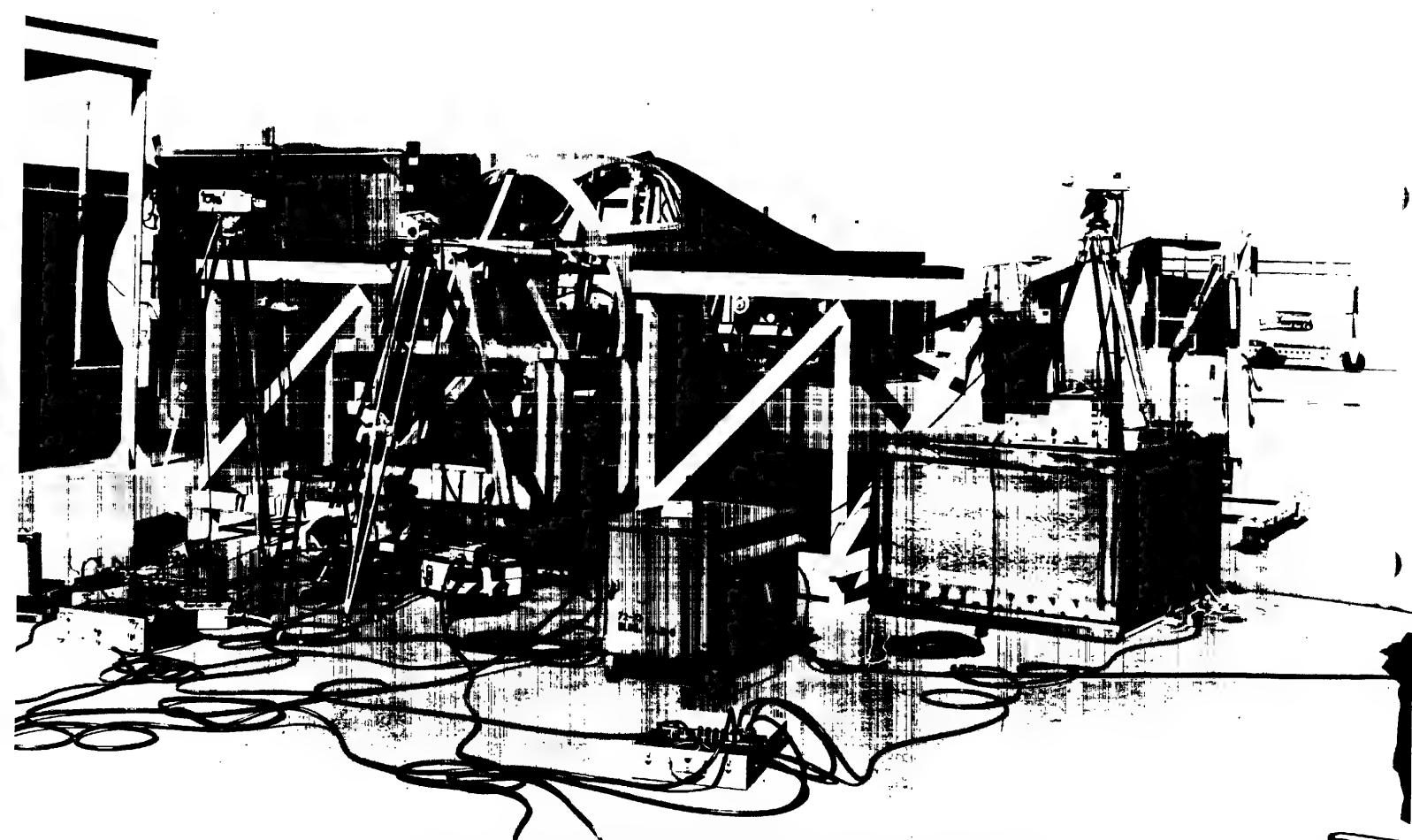
1.0 General Discussion

Following are photographs of the test setups and a series of sequential photos of several facets of this test. These data are presented to provide a reasonably complete report without the need to view the movies.

- 1.1 Photos pages 1 and 2 show the test setup and the sequence during the jettisoning of the canopy. Seat ejection begins 0.3 seconds after pulling the D-ring. The timing of the canopy jettison must clear the seat path. Note that the canopy was out of the way in 0.2 seconds.
- 1.2 In case of malfunction of the canopy jettison system, it may be necessary to eject through the canopy.
- 1.2.1 Photo 3 shows the test setup for the tests including the cameras, fuselage portion in steel mount, with seat and dummy installed. Photo 4 is a close-up of the same setup showing seat and dummy ready to go.
- 1.2.2 Photo 5 shows the start of ejection at ambient temperature. The canopy breaker on the seat has broken the canopy and large pieces of canopy are flying off.
- 1.2.3 Photo 6 shows how much area was cleared for ejection.
- 1.2.4 Photos 7 and 8 show the dry ice box in place. Note that the seat and dummy are in place ready to eject as soon as the canopy reaches -65°F.
- 1.2.5 Photo 9 shows the start of ejection with the canopy at -65°F. The wires shown on the canopy are thermocouples to pick off the canopy temperature. Note the huge piece of canopy broken out by the breaker on the seat.
- 1.2.6 Photo 10 shows how thoroughly the canopy was cleared away.
- 1.2.7 Photos 11 and 12 illustrate how much separation there was between the seat and the dummy. In the movies, due to camera location, it appears that the dummy is landing on, or very near, the seat recovery chute. These photos show a wide dispersal of the order of 100 feet between the seat and the dummy.

- 1.2.8 Photos (page 13) here show the stick stowage sequence of two separate tests.
- 1.2.9 Photos (page 14) here show the test to prove that the addition of the canopy breaker (the white arc across the top of the chute pack) will not impede the deployment of the seat drogue chute. Note that the final picture shows the shroud lines pulled tight by the slug from the drogue gun.
- 1.2.10 Photos (page 15) here show the foot retraction that occurs just prior to ejection.
- 1.2.11 Photos (page 16) here show the extension of the personnel chute by the deployment gun.

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TEST SETUP FOR CANOPY JETTISON

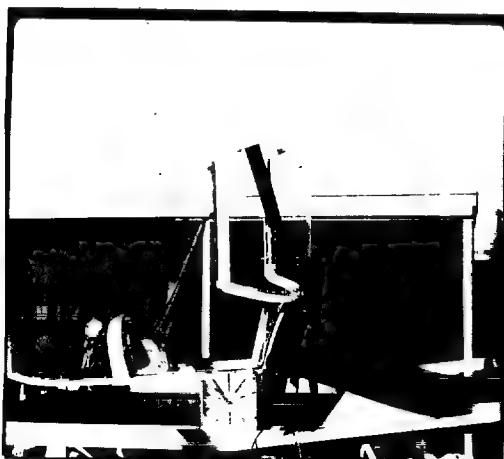
CANOPY JETTISON TEST



1



2



3



4



5



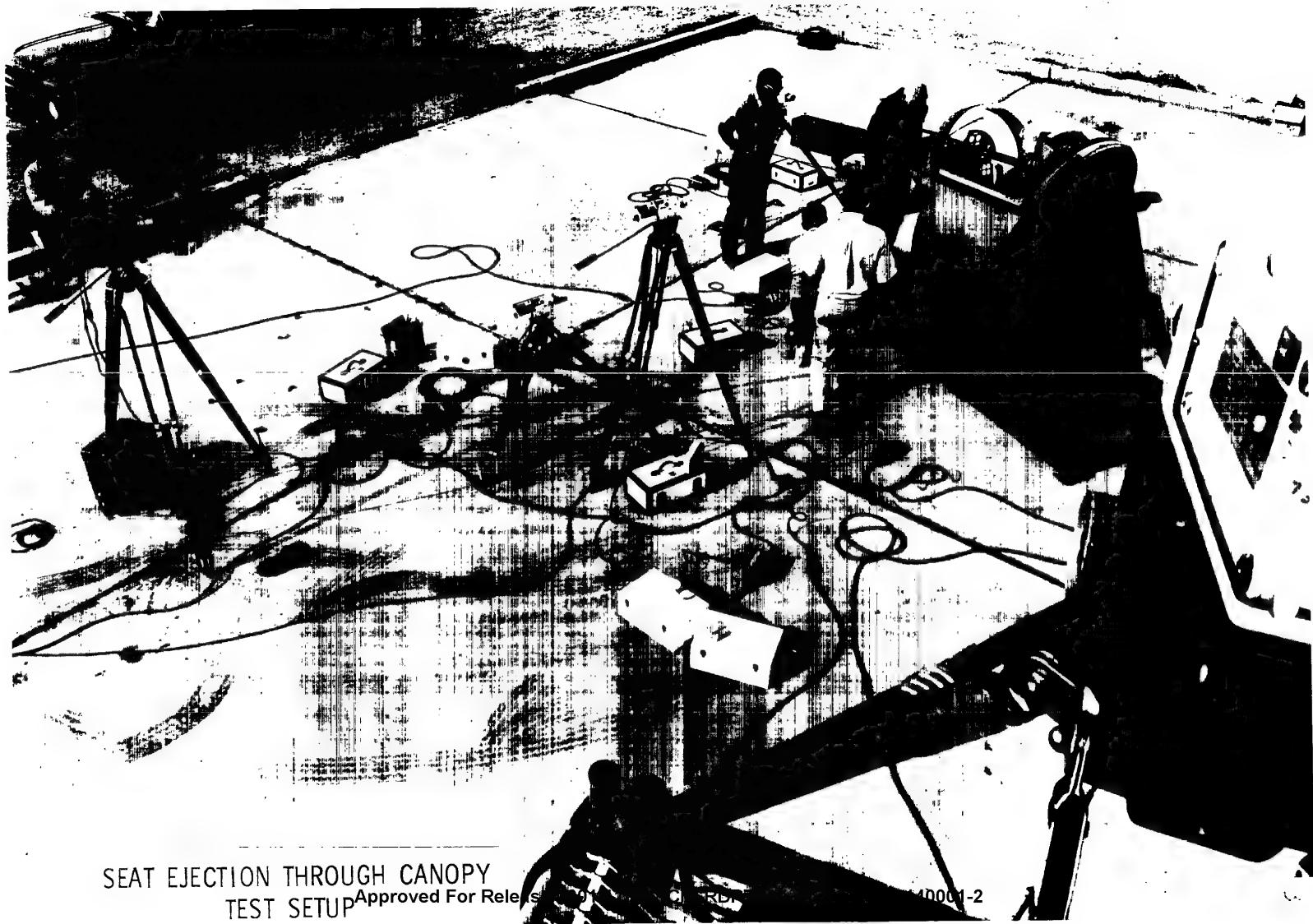
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Photo 1: Note Thruster at right front windshield post.

Photo 2: Note both Thrusters fully extended.

Total elapsed time 0.2 seconds

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SEAT EJECTION THROUGH CANOPY
TEST SETUP

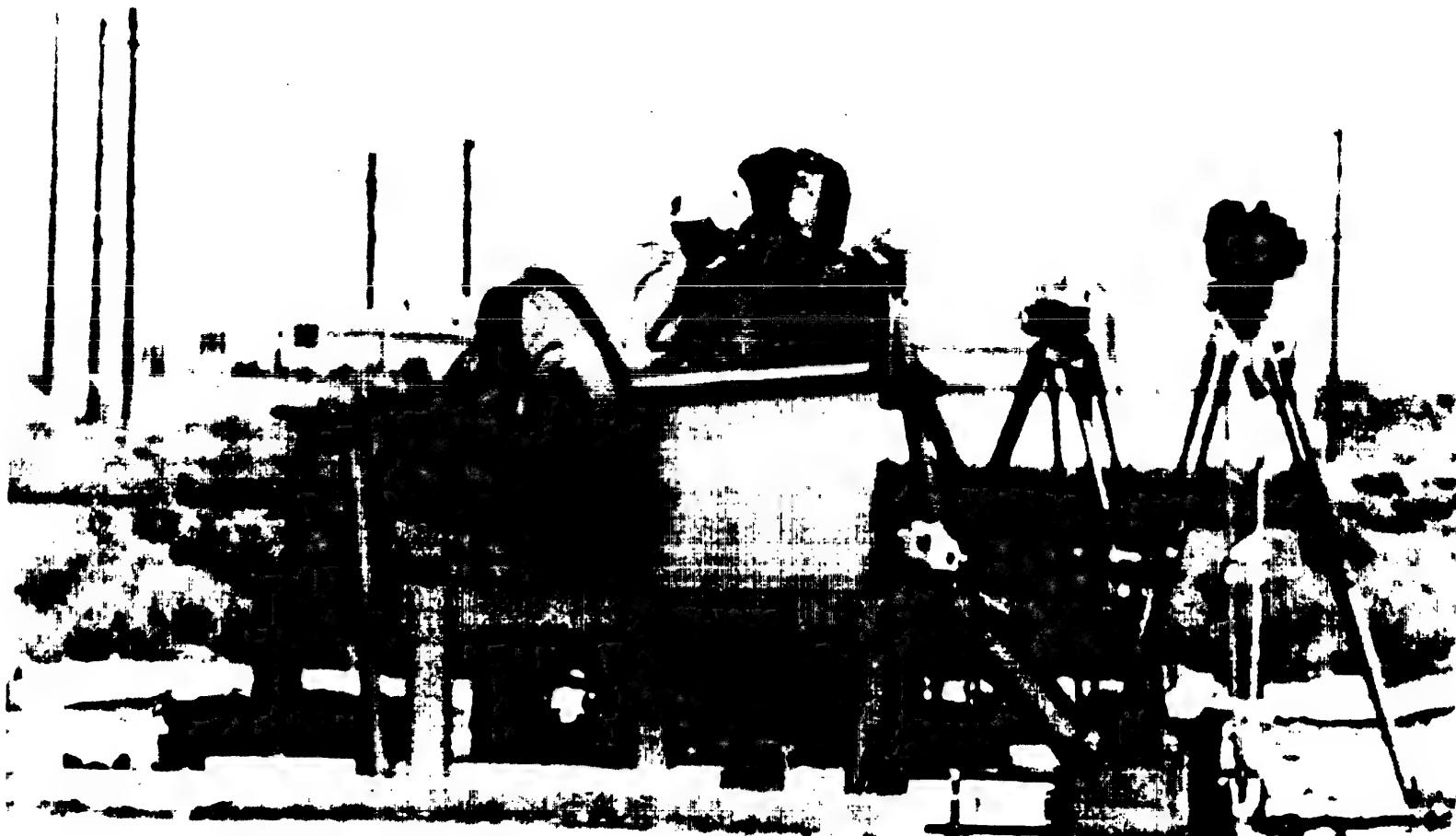
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SEAT EJECTION THROUGH CANOPY
TEST SETUP

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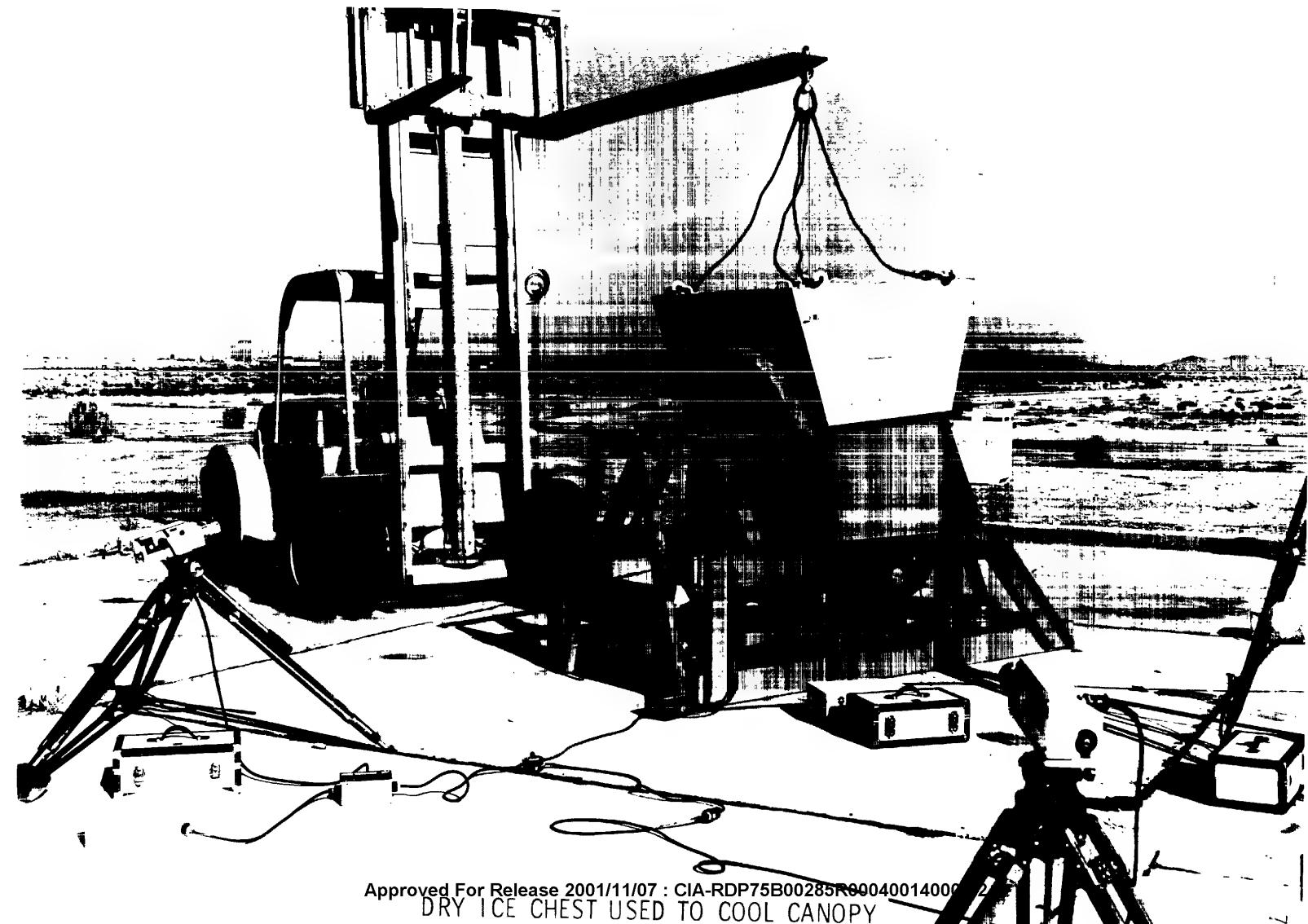
Approved For Release 2001/11/07 : CIA-RDP75B00285R000400140001-2
START OF EJECTION AT AMBIENT TEMPERATURE

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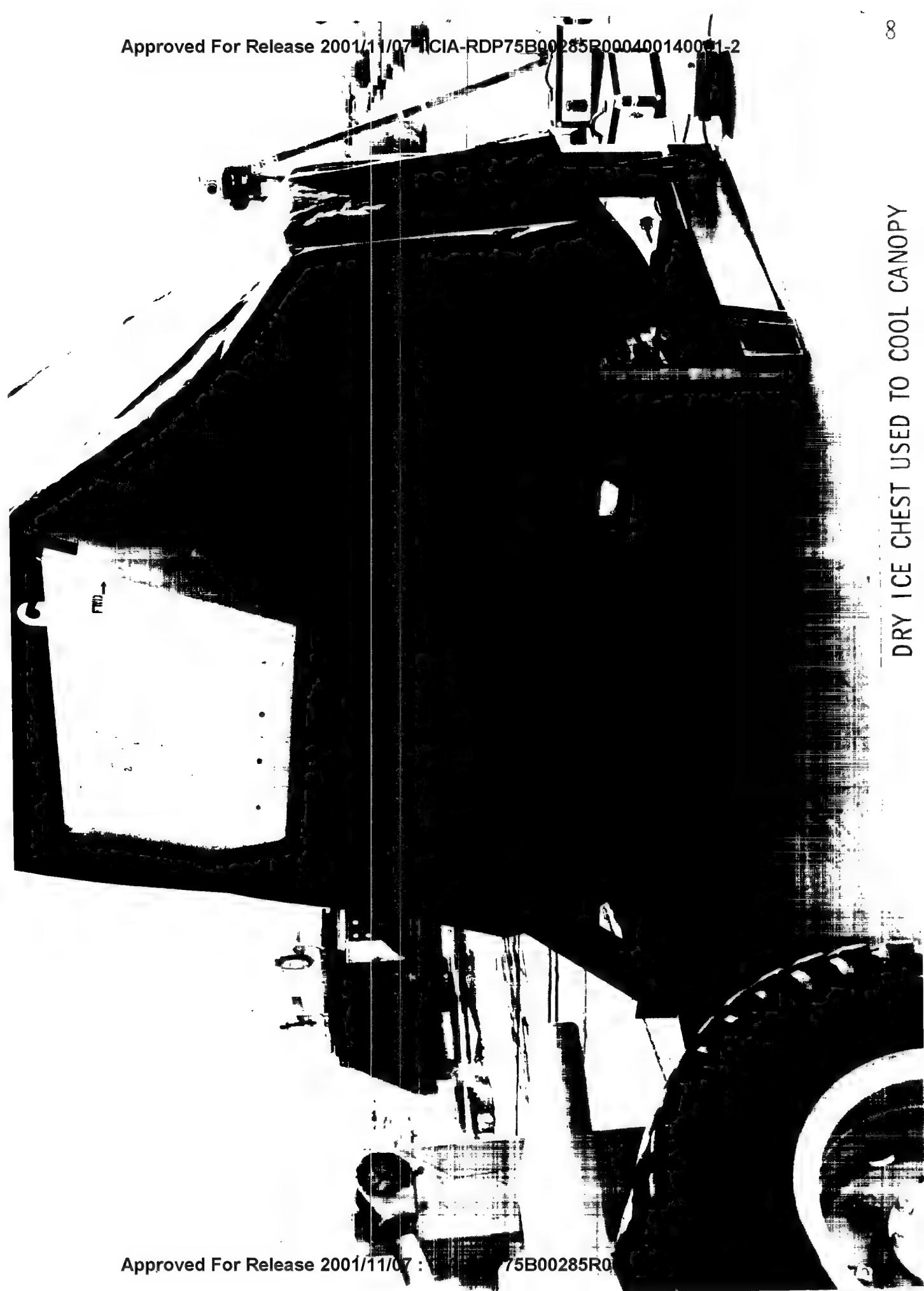


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CANOPY REMAINING AFTER
EJECTION AT AMB. TEMP

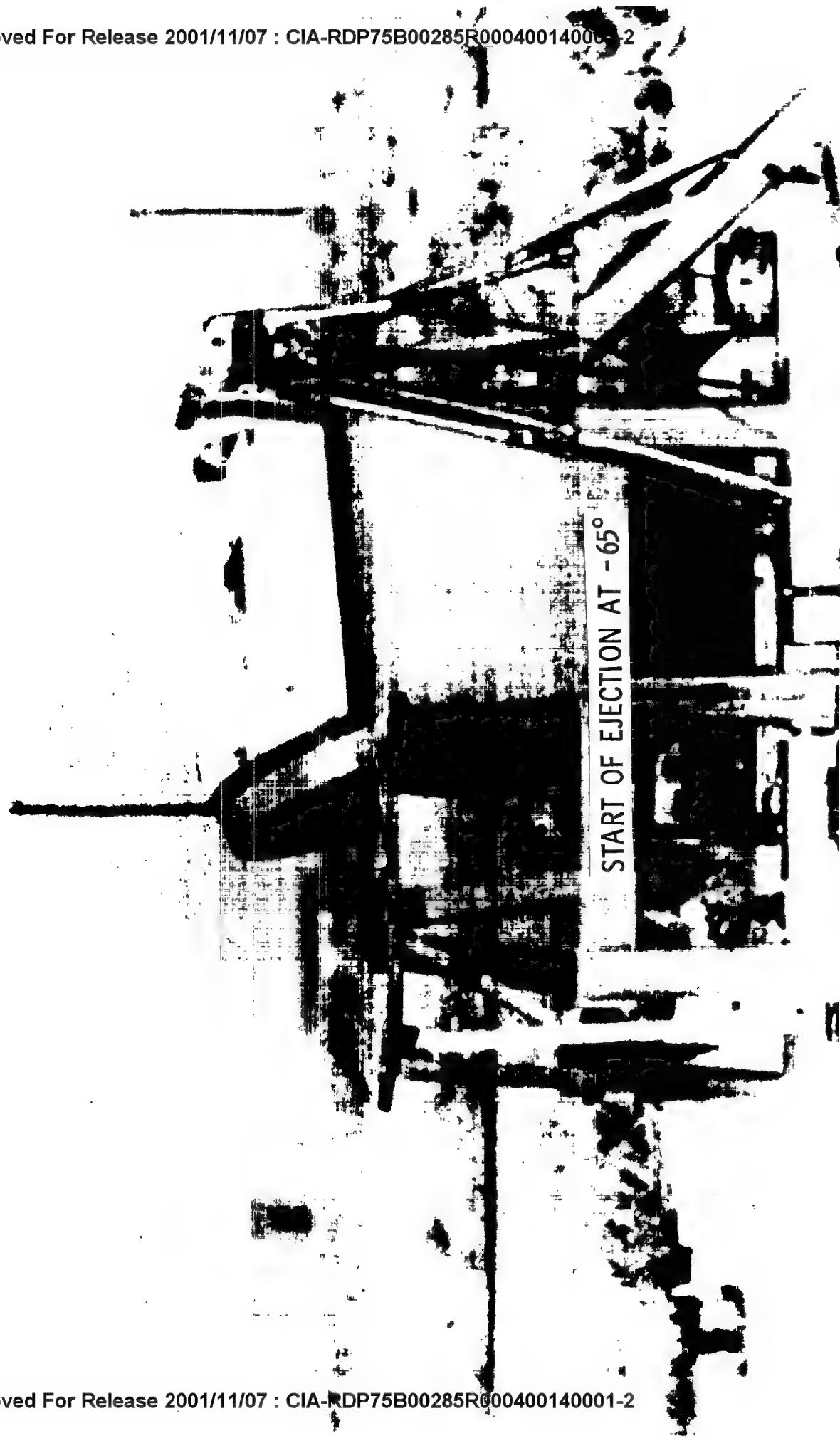
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Approved For Release 2001/11/07 : CIA-RDP75B00285R000400140001-2
DRY ICE CHEST USED TO COOL CANOPY



DRY ICE CHEST USED TO COOL CANOPY



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ILLUSTRATES THE HIGH PERCENT OF
WINDSHIELD CLEARED AWAY BY THE
SEAT IN THE -65°F CANOPY TEST
(Note frost on canopy)

40001-2

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VIEW FROM TEST STAND SHOWING DISTANCE
BETWEEN SEAT AND DUMMY LANDINGS.
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(Personnel at Jeep are retrieving dummy)

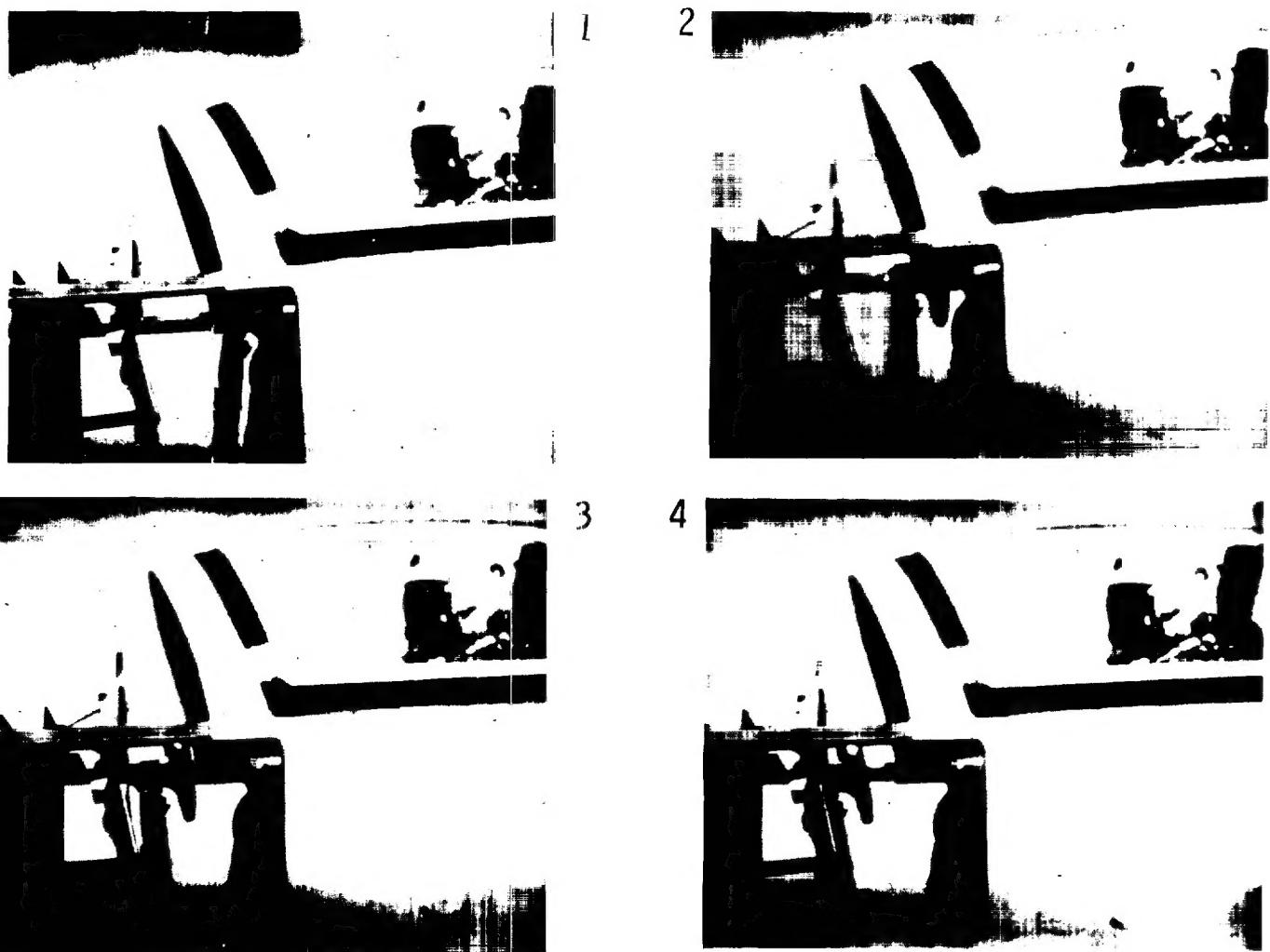
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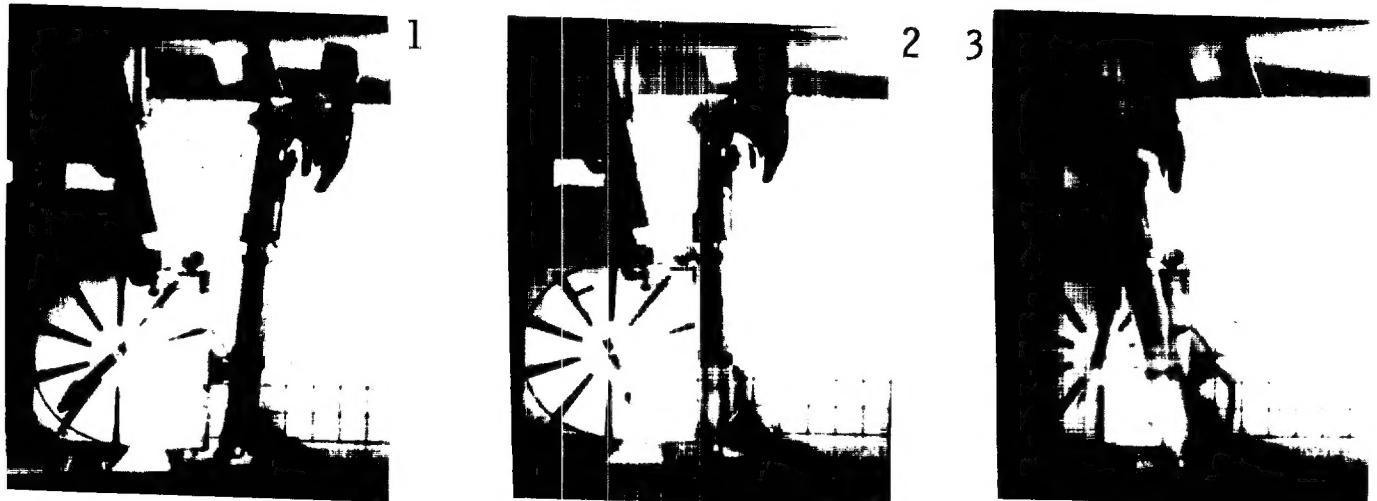
ILLUSTRATES DISTANCE BETWEEN
SEAT AND DUMMY (MEN AT DUMMY)

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CONTROL STICK STOWAGE TESTS



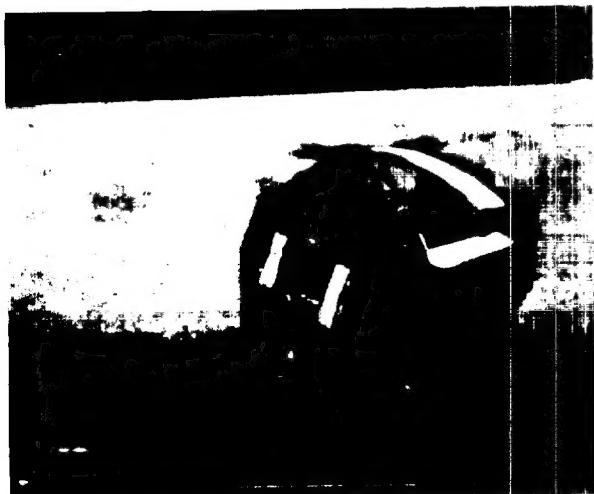
Photos 1 thru 4 show one test.



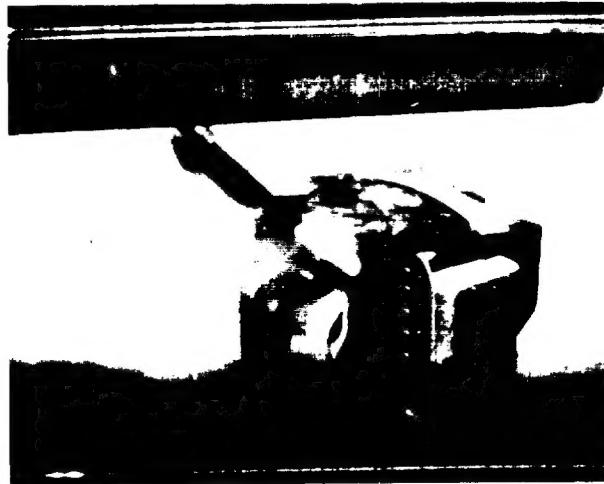
Photos 1 thru 3 show another test.

Time = 0.2 Seconds

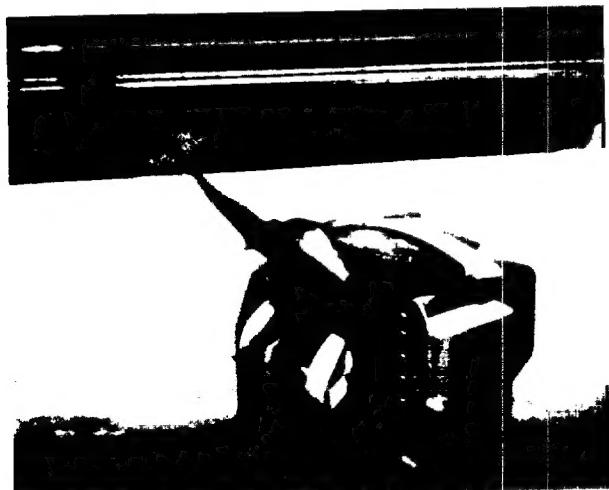
DROGUE CHUTE GUN TEST



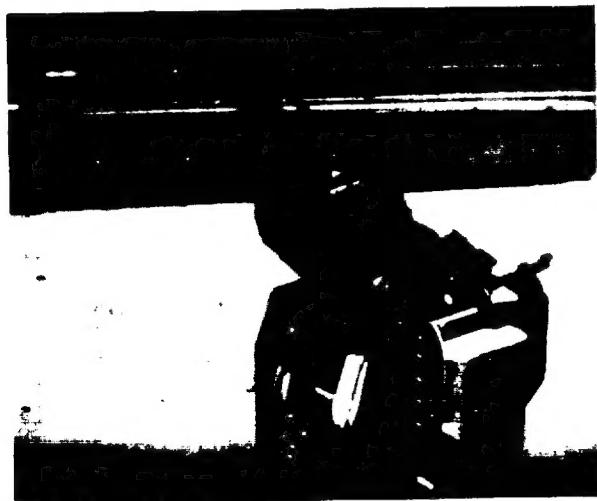
1. Ready



2. Fired



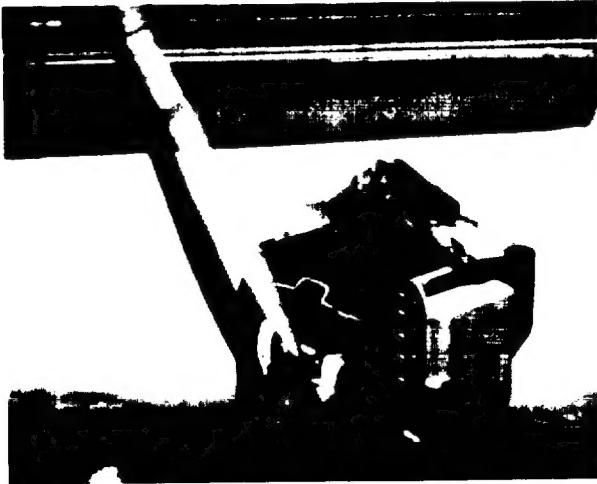
3. Lanyard pullout



4. Chute pullout



5. Shroud lines pullout



6. Shroud lines taut.

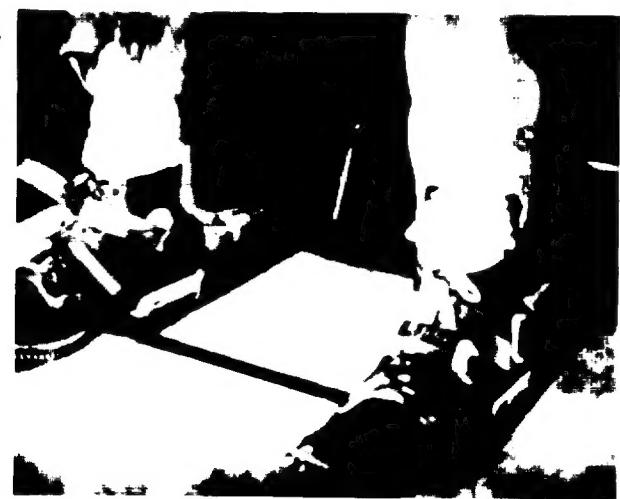
FOOT RETRACTION TEST



Photo 1: - Test Setup



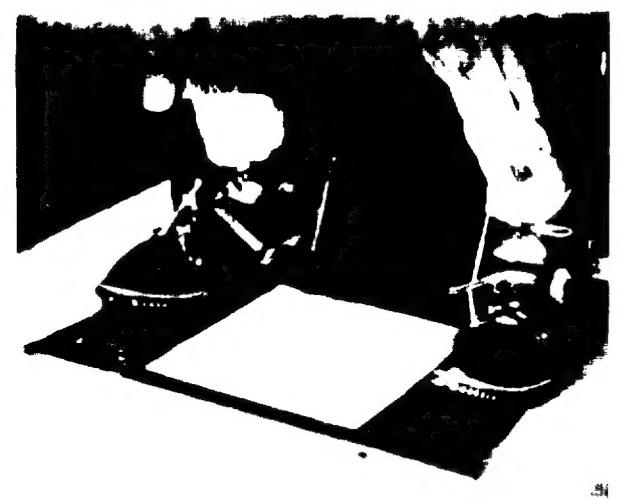
2



3



4



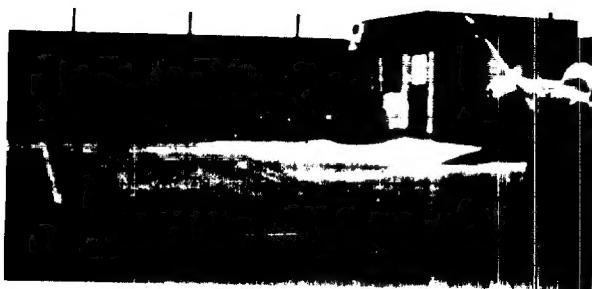
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Photos 2 thru 5 show foot travel during retraction

Time = 0.2 second



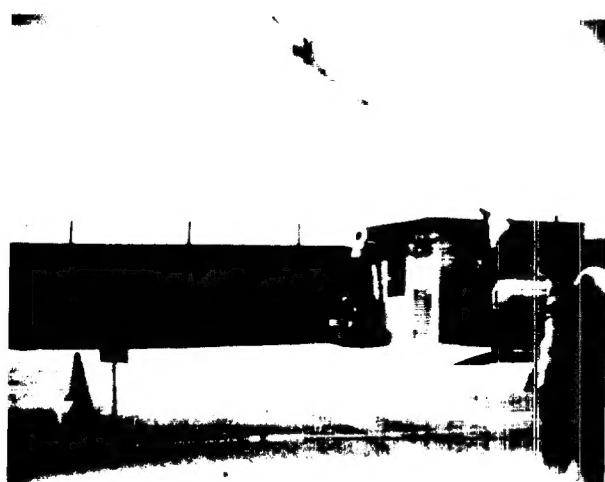
1. Ready



2. Fired



3. Pilot chute pullout



4. Canopy pullout



5. Extent of Pullout.